No Teacher Left Inside: Preparing a New Generation of Teachers

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ABSTRACT

It is ironic that although children often form lasting decisions, at a young age, about their aptitude for and interest in science we are least successful at preparing elementary teachers to nurture their students' science interests. This is despite the fact that most elementary teachers teach in contained classrooms where they are responsible for science content at this critical, developmental stage for their students. Science preparation for preservice, elementary teachers is traditionally relegated to large, general-education lecture courses. Even when these courses have laboratories, they tend to depend on cook-book style exercises where procedures are given and the outcomes are known. This leaves many pre-service, elementary teachers not only ill-prepared, but also fearful of the science content that they must teach. We here advocate a change in the way science is taught to preservice, elementary teachers. By developing hands-on field learning and teaching experiences for these future teachers, we believe that elementary Science, Technology, Engineering, and Math (STEM) education can better encourage more children to become scientists and to encourage all students to become the next generation of informed citizens.
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INTRODUCTION

"If education and other forces, intentionally or unintentionally, continue to push the young away from direct experience in nature, the cost to science itself will be high. Most scientists today began their careers as children, chasing bugs, collecting spiders, and feeling awe in the presence of nature. Since such untidy activities are fast disappearing, how, then, will our future scientists learn about nature?" (Louv, 2008, p. 144)

In *A Sand County Almanac*, Leopold (1949) eloquently described his observations about nature as he watched the seasons pass over Sauk County, WI. In simple but eloquent language, Leopold shared his deep connection with the natural world as he described the sound of melting ice in the first January thaw, the collection of objects delivered by the spring floods, and the succession of blooms that paraded across the countryside from spring through summer. The familiarity with the environment that he shared is one that was once common for people who lived, worked, and understood their dependence on the land. However, that connection is becoming increasingly rare. Today, children spend the majority of their day inside. During the school day, outside play is often replaced with test-prep activities; and after school, many students play inside by choice or out of parent fear of the dangers associated with being outside.

What is the price of a life lived essentially indoors? (Louv, 2008), author of *Last Child in the Woods*, believes the consequences are great. He sounds the alarm about a generation of children growing up with what he describes as "nature deficit disorder." He warns of harmful physical and psychological effects to children who grow up without connections to the natural world. Louv's work has spawned a movement called "no child left inside," a counter to the No Child Left Behind Act of 2001, which cut environmental education out of its agenda and resulted in an overall decrease in instructional time for science (*No child left behind*, 2001; *No child left inside*, 2009). The Center for Education Policy report from their ongoing study on the impacts of No Child Left Behind that 53% of the school districts surveyed cut their science instructional time by 75 min per week (McMurrer, 2008). With less time spent in science education in general, opportunities for authentic, child-directed learning where children actively explore their outdoor surroundings will be decimated.

CHALLENGE TO TEACHERS

Simply encouraging students to play outside is a first-step in ameliorating a child's nature deficit but outdoor exploration must also have a meaningful role in the elementary science curriculum. Elementary teachers frequently have low confidence in their ability to teach science content effectively (Manner, 1998; Abdell and Lederman, 2007). Therefore, attention must be given not only to enhancing teachers' confidence in teaching science content but also in using the outdoors as a classroom where a child's ability to learn through exploration, manipulation, questioning and searching out answers, is fostered (Piaget, 1972). Elementary teachers, as mentors, play a critical role in supporting science learning and research suggests that negative comments by teachers have a greater affect than positive comments at influencing the attitudes of young children (Redd and Winston, 1974; Bell *et al.*, 2009). Children are often eager to please their teachers by emulating the teacher's likes and dislikes. If the teacher avoids outdoor play and exploration and consistently allows his or her discomforts ("EWW, it's a bug!") and fears ("Stay out of the woods, you might get lost.") to dominate the dialogue about the outdoors, students are likely to internalize this behavior and avoid outdoor play where students may take a more self-reflective and nuanced view of scientific process (Sandoval, 2005).

This potentially self-perpetuating cycle of avoidance has devastating implications for science education (Louv, 2008; Pergams and Zaradic, 2008; and Bell *et al.*, 2009) because

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students' attitudes toward science in early adolescence is a strong predictor of science degree attainment (Tai *et al.*, 2006). As (Carson, 1965) wrote, "If a child is to keep alive his inborn sense of wonder, he needs the companionship of at least one adult who can share it, rediscovering with him the joy, excitement and mystery of the world we live in (p. 41)." As today's parents are also members of the "inside generation," teachers are increasingly important as the adult who can share childhood excitement and instill curiosity by introducing their students to the natural mysteries around them. Teachers using inquiry methods "should capture that spirit of scientific investigation and the development of knowledge about the natural world" (Bybee, 2004).

NEED FOR CHANGE

Unfortunately, a new generation of teachers is growing up indoors lacking a basic understanding of the natural world either from personal experience or formal education. Stevermer *et al*. (2007) state "despite the undeniable importance of having a working knowledge of this planet that is their home, more than 70% of US students are likely to graduate without having completed a high school course in Earth Science." This lack of outdoor inquiry based science learning continues at the university level where many elementary and early childhood teacher-training programs only require one or two science courses (Schwimmer and Hester, 2008). These undergraduate science courses are primarily large-enrollment lecture classes that focus on covering content rather than engaging students in the process of science (National Research Council [NRC], 1996; Brown *et al*., 2006). Using a passive pedagogy, the science courses taken by elementary education majors rarely incorporate outdoor experiences and are typically not aimed at helping them learn to teach the science content they are learning (Cantrell *et al*., 2003; Dickerson *et al*., 2007).

The problem is twofold. First, how can we provide essential outdoor learning experiences to a generation who is growing up indoors if formal schooling neglects this important aspect of science? Second, how do we help elementary teachers become comfortable creating and developing positive outdoor science learning experiences for their students? Universities are challenged to address preservice teachers' need for formal science instruction that is scientifically robust and readily transferable to elementary teaching and learning. By preparing the next generation of elementary teachers to teach science using the outdoors, we have the potential to reach an entire generation of children.

PROMISING ADVANCES

In recent years, there has been a "call for change" in the wider geoscience community. *Blueprint for Change: A Report From The National Conference on the Revolution in Earth and Space Science Education* (Barstow and Geary, 2002) advocates the use of inquiry-based learning and visualization technologies to help students use geoscience knowledge to solve real-world problems. If we expect preservice teachers to use inquiry methods in their future classrooms, they must experience inquiry teaching and learning in their own undergraduate education. (Apedoe, 2008) used inquiry methods in his undergraduate geology laboratory-based course and found that undergraduate geoscience majors truly engage in inquiry, rather than superficially engaging in the science activities. But inquiry instruction is a new and often uncomfortable experience for both the undergraduate students and Teaching Assistant (TA's) early in the course (Apedoe, 2008; Bykerk-Kauffman, 2008).

(Mattox *et al*., 2008) specifically tackled the unique science education needs of undergraduate preservice elementary teachers by carefully crafting a coherent "four course sequence of undergraduate science courses that promotes the development of content and conceptual Earth systems knowledge, geoscience pedagogical knowledge, and understanding the critical role human beings play in the natural environment." The courses are part of a larger integrated science program for k-8 teachers. The program teaches undergraduate science content using inquiry methods that highlight the interdisciplinary nature of geoscience. Another benefit of this program is the intentional inclusion of opportunities for student to develop pedagogical skills via course assessments that include model teaching, curriculum creation, and k-8 classroom field experiences. As (Apedoe, 2008) explains, "it is important to note that inquiry is not a context-free activity." In (Mattox *et al*., 2008) situation, context includes both content and setting. Preservice teachers learn science content via inquiry and are assessed in their ability to translate their learning to the k-8 setting where they will be teaching (Mattox *et al*., 2008). (Schwimmer and Hester, 2008) also created a course for k-8 preservice teachers specifically designed to integrate scientific content and pedagogical practice. They found that after completing their field-based marine science course, preservice teachers exhibited a general increase in both their attitudes toward the importance of science and in their perceived ability to do science (Schwimmer and Hester, 2008).

THE SOLUTION

To help this new generation of elementary teachers develop a comfort with outdoor learning, we believe that there needs to be a transformative shift in how teachers themselves are taught science in college. Too often, preservice elementary teachers leave their current undergraduate science courses with limited content knowledge, an inaccurate view of the nature of science, and no confidence in their ability to teach science content to their future students (Bell *et al*., 1998, 2000); and (Abdell and Lederman, 2007). This translates into a crisis at the elementary classroom level where science is either avoided or poorly taught (Weiss *et al*., 2003). This is especially troublesome because, along with parents, teachers have the greatest influence on children's science attitudes (George and Kaplan, 1998). According to (Yager, 2009), "The challenge for all who want to improve education is to create an educational system that exploits the natural curiosity of children so that they maintain their motivation for learning not only during their school years but throughout life." To accomplish this we must cultivate children's natural tendency to ask, "why".

> Most young children are naturally curious. They care enough to ask "why" and "how" questions. But if adults dismiss their incessant questions as silly and uninteresting, students can lose this gift of curiosity. Visit any second grade classroom and you will generally find a class bursting with energy and excitement, where children are eager to make new observations and try to figure things out. What a contrast with many eighth-grade classes, where the students so often seem bored and disengaged from learning and from school! (NRC 2000, p. xii)

First and foremost, for American science education to improve in a manner that addresses all children's need for outdoor, hands-on experiences, elementary teachers' undergraduate education must include science instruction that employs authentic inquiry-based learning experiences in the outdoors using curriculum that models best teaching practice. Future elementary teachers need science content courses that model how to use the outdoors as the classroom space and as the basis for teaching science fundamentals. By moving introductory science away from the large, lecture-driven, cookbook lab, passive learning environment, to a hands-on, collaborative, outdoor learning experience, a new generation of teachers will acquire a sense of comfort and purpose in the outdoors that may not have been cultivated as a child. Reversing the cycle of avoidance of the outdoors can begin with teacher training. The undergraduate science experiences of future teachers needs to excite, inspire, and equip them with the skills necessary to lead a generation of children into the world of science.

Second, preservice early-childhood and elementary teachers must practice science and practice engaging young children in science. Simply teaching through inquiry methods does not ensure that our teachers will transfer this knowledge and experience into their future classroom. In fact, multiple studies show that teachers are not comfortable with or capable of transferring their science content knowledge to effective teaching practice (National Science Resource Center, 1997; Lieberman and Hoody, 1998; Nelson, 1999; Akerson *et al.*, 2000; and Donovan and Bransford, 2005). Therefore, we must not only teach robust science content, but we must also provide opportunities for preservice teachers to practice teaching this content. Preservice teachers should develop lessons, teach these lessons to young children, and revise and improve their teaching practice based upon feedback from experienced professionals. By focusing on improving the undergraduate science experience of new teachers we can equip this new generation of elementary teachers with the skills necessary to improve the quality of science teaching and learning for elementary students who will be both future scientists and informed citizens.

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